# ENVIRONMENTAL LEVELS OF RADIOACTIVITY FOR THE OAK RIDGE AREA

Report for Fourth Quarter 1960

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## Introduction

Radioactive waste materials arising from the operation of atomic energy installations at Oak Ridge are collected, treated, and disposed of according to their physical states.

Solid wastes are buried in a Conasauga shale formation. This shale has a marked ability to fix radioactive materials by an ion exchange mechanism.

Liquid wastes which contain long-lived fission products are confined in storage tanks or are released to pits located in the Conasauga shale formation. Low level liquid wastes are discharged, after preliminary treatment, to the surface streams.

Air that may become contaminated by radioactive materials is exhausted to the atmosphere from several tall stacks after treatment by means of filters, scrubbers, and/or precipitators.

This report presents data on the environmental levels of radioactivity for the Oak Ridge Area and compares the data with established maximum permissible concentrations.

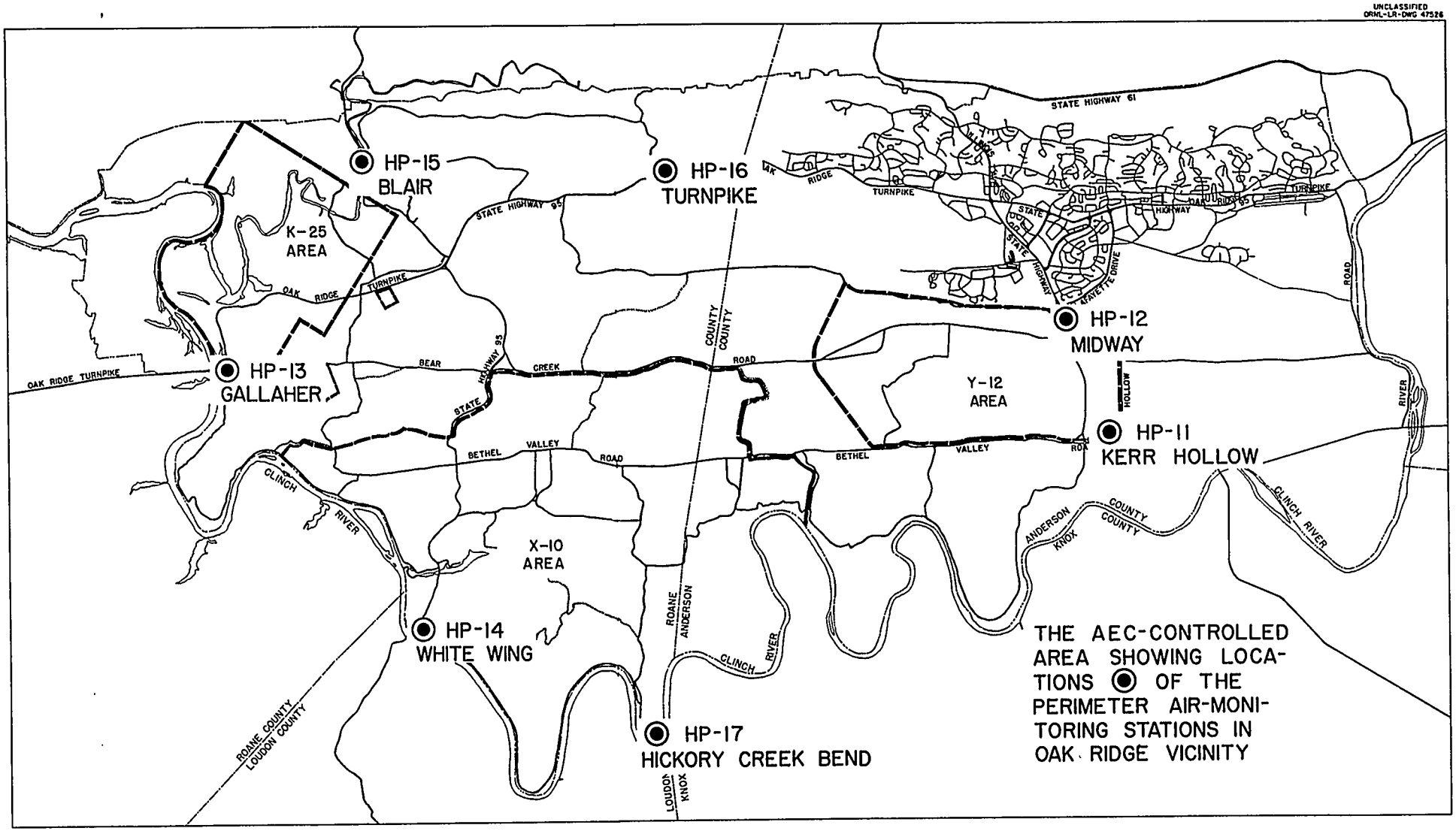
## Air Monitoring

Atmospheric contamination by long-lived fission products and fall-out occurring in the general environment of East Tennessee are monitored by two systems of monitoring stations. One system consists of seven stations which encircle the plant areas (Fig. 1) and provides data for evaluating the impact of all Oak Ridge Operations on the immediate environment. A second system consists of eight stations encircling the Oak Ridge Area at distances of from 12 to 120 miles (Fig. 2). This system provides data to aid in evaluating local conditions and to assist in determining the spread or dispersal of contamination should a major incident occur. Sampling is carried out by passing air continuously through a filter paper. The filter paper will collect those particulates considered to be respirable. Data collected are accumulated and tabulated in average $\mu c/cc$ of air sampled.

Atmospheric contamination by uranium is determined by taking periodic air samples at seven locations on a two-mile radius and at seven locations on a five-mile radius from the Oak Ridge Gaseous Diffusion Plant (Fig. 3).

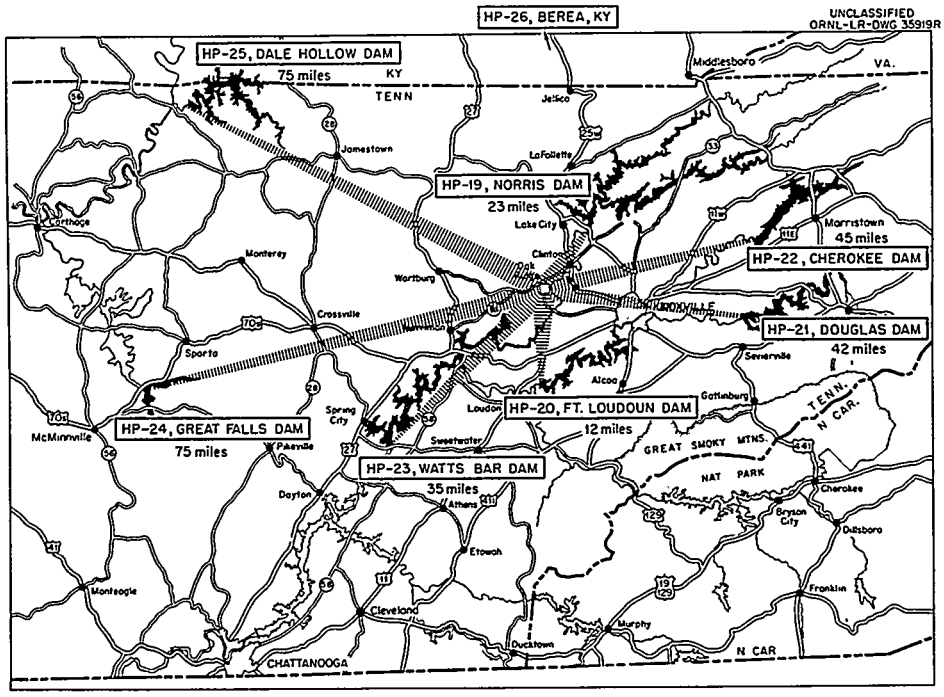
## Water Monitoring

Large volume, low level liquid wastes originating at Oak Ridge National Laboratory are discharged, after some preliminary treatment, into the Tennessee River system by way of White Oak Creek and the Clinch River. Liquid wastes originating at the Oak Ridge Gaseous Diffusion Plant and the Y-12 Plant are discharged to Poplar Creek and thence to the Clinch River. Releases are controlled so that resulting average concentrations in the Clinch River comply



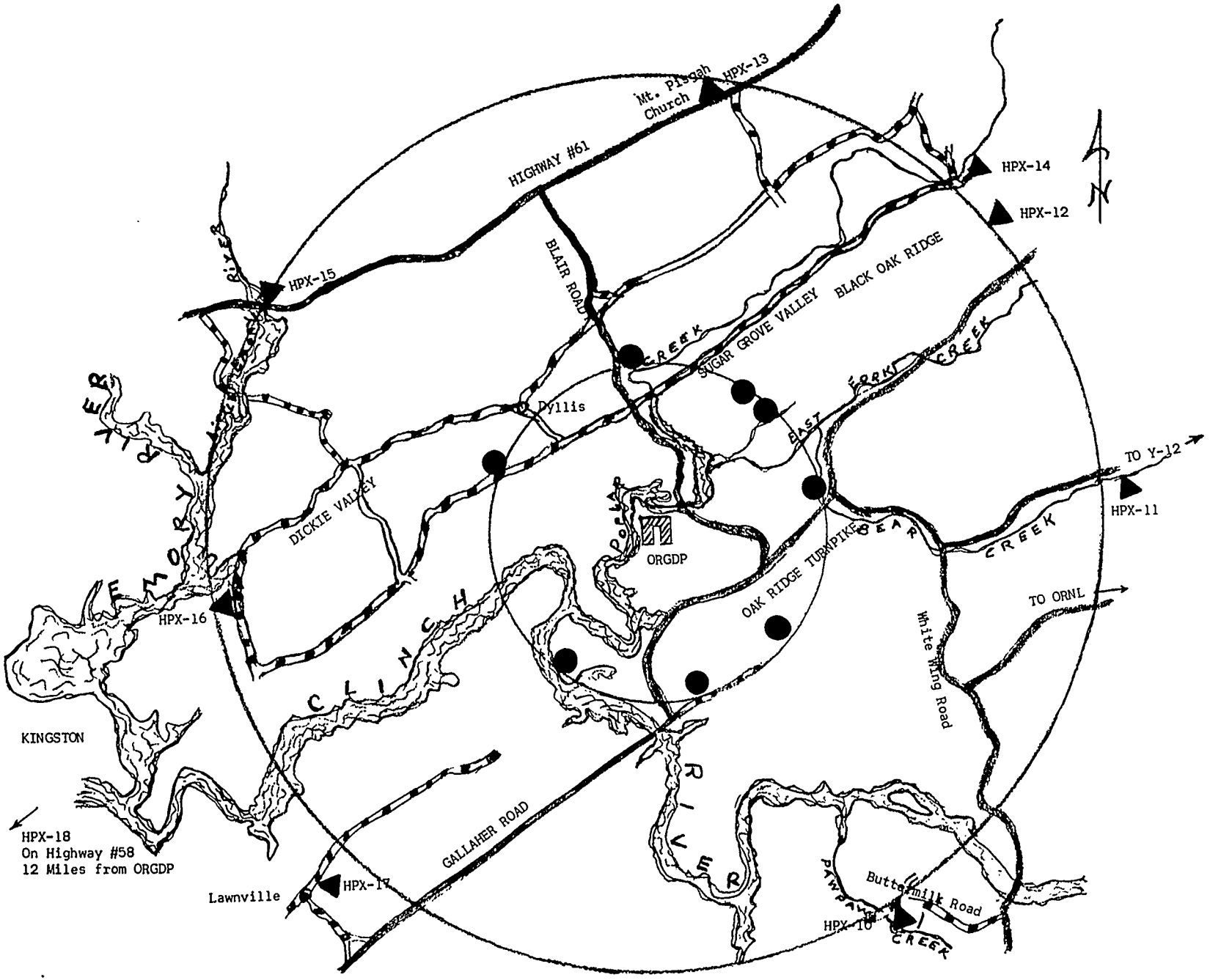

STATION SITES FOR PERIMETER AIR MONITORING SYSTEM

Figure 1




STATION SITES FOR REMOTE AIR MONITORING SYSTEM

Figure 2




SAMPLING POINTS OF OUTSIDE ENVIRONS -- ORGDP

▲ Sampling Location - 5 Miles from Plant

● Sampling Location - 2 Miles from Plant

with the maximum permissible levels for populations in the neighborhood of a controlled area as recommended by the National Committee on Radiation Protection (NCRP). The concentration of radioactivity leaving White Oak Creek is measured and concentration values for the Clinch River are calculated on the basis of the dilution provided by the river.

Radioactive liquid wastes are sampled at a number of locations as shown in Figs. 4 and 5. Samples are taken at a number of locations in the Clinch River, beginning at a point above the entry of wastes into the river and ending at Center's Ferry near Kingston, Tennessee. Stream gauging operations are carried on continuously by the United States Geological Survey to obtain dilution factors for calculating the probable concentrations of wastes in the river.

Samples are analyzed for the long-lived beta emitters, for uranium, and for the transuranic alpha emitters.

The fraction of the total beta activity comprised by each isotope is determined from analysis of long-lived radionuclides contained in the effluent and a weighted average maximum permissible concentration for water, $(MPC)_w$, for the mixture of radionuclides is calculated on the basis of the isotopic distribution using the MPC values of each isotope as recommended by the NCRP. The average concentrations of gross beta activity in the Clinch River are compared to the calculated $(MPC)_w$ values.

The concentration of uranium is compared with the specific $(MPC)_w$ value for uranium.

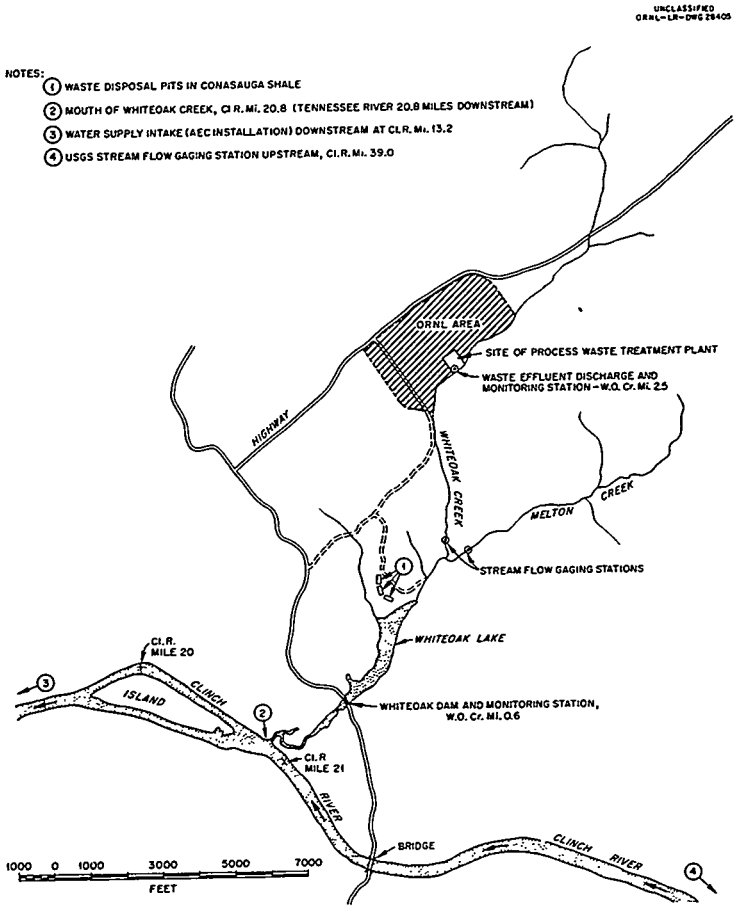
## Gamma Measurements

External gamma radiation levels are measured monthly at a number of locations in the Oak Ridge Area. Measurements are taken with a Geiger-Muller tube at a distance of three feet aboveground and the results are tabulated in terms of mr/hr.

## Discussion of Data

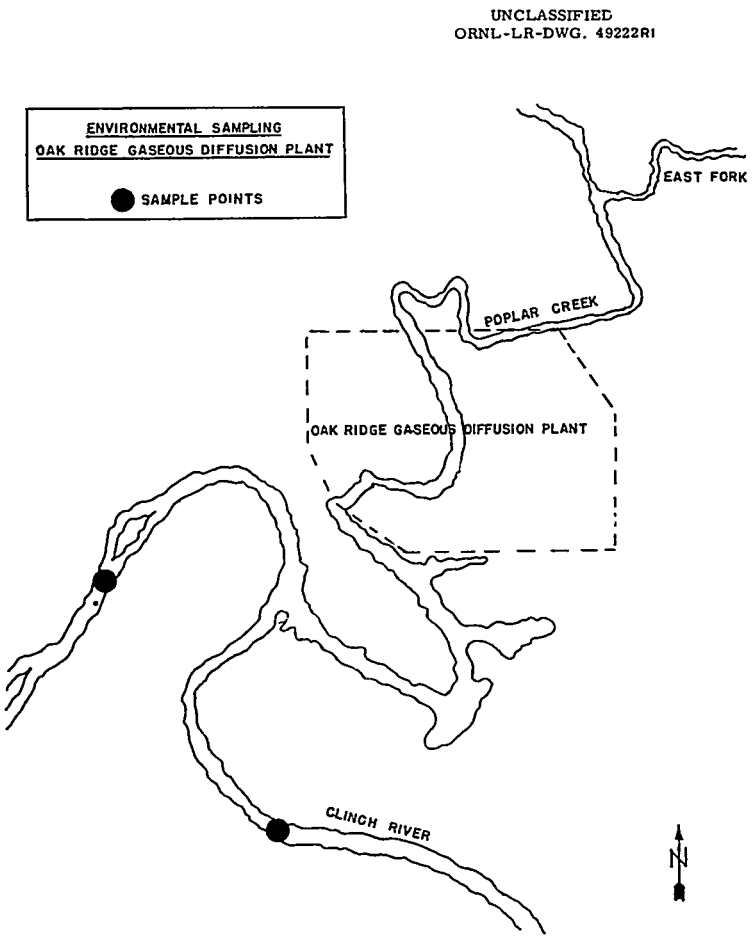
Data on the environmental levels of radioactivity for the fourth quarter of 1960 in the Oak Ridge and surrounding areas are presented in Table I through Table VI.

The air contamination level for gross $\beta$ activity as shown by the continuous air monitoring filter data for both the immediate and remote environs of the plants was 0.05% of the maximum permissible concentration for populations in the neighborhood of a controlled area. The levels measured during this period were not significantly different from those measured in other areas of the United States and reported by the U. S. Public Health Service Radiation Surveillance Network.




Location Sketch Map
ORNL Area Surface Drainage

Figure 4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ENVIRONMENTAL SAMPLING
OAK RIDGE GASEOUS DIFFUSION PLANT
SAMPLE POINTS
EAST FORK
POPLAR CREEK
OAK RIDGE GASEOUS DIFFUSION PLANT
CLINCH RIVER
N

Figure 5

The average air-borne alpha activity in the environs of the ORGDP as determined from the results of ten-minute spot samples at locations two and five miles from the plant was slightly above the normally low level. A single period of increased activity which occurred early in November was coincident with a pilot stage run being made with highly enriched uranium materials and was largely responsible for this increase. Following completion of the short run, background values were again rapidly re-established; modification of the involved process is being studied. Of the 427 eight-hour continuous samples obtained in those plant operations areas where stack or vent discharge of uranium materials is possible, less than 1% were above the maximum permissible concentration for occupational exposure and the average was only a small fraction of this concentration.

The calculated average concentration of radioactivity in the Clinch River at Mile 20.8, the point of entry of most waste materials, and at Mile 4.5, near Kingston, Tennessee, were $7.0 \times 10^{-7}$ μc/cc and $6.0 \times 10^{-7}$ μc/cc respectively. These values are 22% and 17% of the weighted average maximum permissible concentration as recommended by the National Committee on Radiation Protection. The rise in concentration of radioactivity in the Clinch River during this quarter reflects an increase in the quantity of radioactive materials discharged. The average concentration of transuranic alpha emitters in the Clinch River at Mile 20.8 was $1.4 \times 10^{-11}$ μc/cc which is 0.0004% of the weighted average $(MPC)_w$ value.

The average activity of natural uranium materials in the Clinch River, reflecting the effects of all of the Oak Ridge Plants, was only 0.01% of the $(MPC)_w$ for uranium.

External gamma radiation in the Oak Ridge Area averaged 0.015 mr/hr. This level is not significantly different from the average of the levels measured throughout the United States by the U. S. Public Health Service Radiation Surveillance Network.

## Conclusion

From the data presented, it seems evident that the Oak Ridge Operations are contributing little to the air or ground contamination in the neighborhood of the area controlled by the Atomic Energy Commission.

Some radioactivity has been contributed to the Clinch River by the release of radioactive liquid wastes, but concentrations of radioactivity in the river are well below the maximum permissible concentration recommended by the NCRP for populations living in the vicinity of an atomic energy installation.

TABLE I

CONTINUOUS AIR MONITORING DATA

Long-Lived Fission Products

Fourth Quarter 1960

| Station Number | Location | Number of Samples Taken | Units of $10^{-13}$ µc/cc | | | % of (MPC)a* |
|---|---|---|---|---|---|---|
| | | | Maximum | Minimum | Average | |
| | | Perimeter Stations | | | | |
| HP-11 | Kerr Hollow Gate | 13 | 0.96 | 0.04 | 0.37 | 0.04 |
| HP-12 | Midway Gate | 13 | 1.80 | 0.20 | 0.50 | 0.05 |
| HP-13 | Gallaher Gate | 13 | 0.72 | 0.24 | 0.50 | 0.05 |
| HP-14 | White Wing Gate | 13 | 0.72 | 0.20 | 0.46 | 0.05 |
| HP-15 | Blair Gate | 13 | 0.89 | 0.24 | 0.52 | 0.05 |
| HP-16 | Turnpike Gate | 13 | 1.09 | 0.12 | 0.46 | 0.05 |
| HP-17 | Hickory Creek Bend | 13 | 1.06 | 0.15 | 0.41 | 0.04 |
| Average | | | | | 0.46 | 0.05 |
| | | Remote Stations | | | | |
| HP-19 | Norris Dam | 13 | 2.66 | 0.39 | 0.80 | 0.08 |
| HP-20 | Loudoun Dam | 13 | 0.81 | 0.25 | 0.49 | 0.05 |
| HP-21 | Douglas Dam | 13 | 0.99 | 0.12 | 0.46 | 0.05 |
| HP-22 | Cherokee Dam | 13 | 0.75 | 0.14 | 0.41 | 0.04 |
| HP-23 | Watts Bar Dam | 13 | 0.78 | 0.27 | 0.52 | 0.05 |
| HP-24. | Great Falls Dam | 13 | 0.62 | 0.31 | 0.49 | 0.05 |
| HP-25 | Dale Hollow Dam | 12 | 0.69 | 0.18 | 0.38 | 0.04 |
| HP-26 | Berea, Kentucky | 12 | 0.63 | 0.12 | 0.34 | 0.03 |
| Average | | | | | 0.49 | 0.05 |

* (MPC)a is taken to be $10^{-10}$ µc/cc as recommended in NBS Handbook 69, Table 4, p. 94.

TABLE II

OAK RIDGE GASEOUS DIFFUSION PLANT AIR MONITORING DATA

URANIUM

Fourth Quarter 1960

| Distance from Center of Plant | Type of Analyses | No. of Samples | Units of $10^{-13}$ µc/cc | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Direction from Plant | | | | Average | (MPC)a | % (MPC)a |
| | | | North | East | South | West | | | |
| 2-Mile Radius* | Uranium Concentration | 42 | 1.16 | 0.81 | 1.69 | 0.0 | 1.11 | 20 | 5.6 |
| 2-Mile Radius** | " | 16 | 270 | 312 | 39 | 180 | 188 | | |
| 5-Mile Radius* | " | 40 | 7.10 | 2.54 | 1.62 | 2.6 | 3.06 | 20 | 15.3 |
| 5-Mile Radius** | " | 16 | 169 | 93 | 49 | 169 | 110 | | |

* Reflects normal levels existing over most of quarter.

** Reflects increased levels existing for a single sample period. See discussion on Page 8, paragraph 1.

TABLE III

CALCULATED AVERAGE CONCENTRATION OF RADIOACTIVITY
IN THE CLINCH RIVER AT MILE 20.8

Fourth Quarter 1960

| Number of Samples Taken | Units of $10^{-7}$ µc/cc | | | % of (MPC)w |
|---|---|---|---|---|
| | Maximum | Minimum | Average | |
| 91 | 59 | 1.7 | 7.0 | 22 |

TABLE IV

AVERAGE CONCENTRATION OF MAJOR RADIOACTIVE CONSTITUENTS
IN THE CLINCH RIVER

Fourth Quarter 1960

| Location | Units of $10^{-8}$ µc/cc | | | | | | | % of MPC |
|---|---|---|---|---|---|---|---|---|
| | $Sr^{90}$ | $Ce^{144}$ | $Cs^{137}$ | $Ru^{103-106}$ | $Co^{60}$ | Average Gross Beta Activity | $(MPC)_w^a$ | |
| Mi. 37.5 | .05 | .04 | * | * | * | 0.14 | 27 | 0.5 |
| Mi. 20.8[b] | 0.71 | 0.16 | 0.39 | 28 | 0.86 | 70 | 320 | 22 |
| Mi. 4.5 | 1.3 | 0.11 | 0.14 | 40 | 0.81 | 60 | 345 | 17 |

[a] Weighted average $(MPC)_w$ calculated for the mixture using $(MPC)_w$ values for specific radionuclides recommended in the NBS Handbook 69.

[b] Values given for this location are calculated values based on levels of waste released and the dilution afforded by the river.

* None detected.

TABLE V

URANIUM CONCENTRATION IN THE CLINCH RIVER

Fourth Quarter 1960

| Sampling Point | Type of Analyses Made | No. of Samples | Units of $10^{-8}$ µc/cc | | | | % (MPC)w |
|---|---|---|---|---|---|---|---|
| | | | Maximum | Minimum | Average | (MPC)w | |
| Upstream from ORGDP | Uranium Concentration | 7 | 0.28 | < 0.07 | 0.14 | 2000 | < 0.01 |
| Downstream from ORGDP | " | 7 | 1.5 | 0.07 | 0.27 | 2000 | 0.01 |

Normal Sampling Frequency: Continuous, composited over one week.

TABLE VI

EXTERNAL GAMMA RADIATION LEVELS

mr/hr

Fourth Quarter 1960

| Station Number | Location | October | November | December | Average |
|---|---|---|---|---|---|
| 1 | Solway Gate | .012 | .016 | .012 | .013 |
| 2 | Y-12 East Portal | .012 | .014 | .013 | .013 |
| 3 | Newcomb Road Oak Ridge, Tenn. | .015 | .013 | .013 | .014 |
| 4 | Gallaher Gate | .020 | .015 | .016 | .017 |
| 5 | White Wing Gate | .018 | .015 | .015 | .016 |
| Average | | | | | .015 |